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SUMMARY AND RECOMMENDATIONS

Illinois Resource Information System Feasibility Study Final Report

April 30, 1972

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SUMMARY AND RECOMMENDATIONS

ILLINOIS RESOURCE INFORMATION SYSTEM

Feasibility Study

Final Report

April 30, 1972

Center for Advanced Computation
University of Illinois at Urbana-Champaign
Urbana, Illinois 61801

This work was supported by the
Illinois Institute for Environmental Quality

SUMMARY AND RECOMMENDATIONS

In May, 1971, the Illinois Institute for Environmental Quality contracted with the University of Illinois Center for Advanced Computation for a study of the need for and the feasibility of developing a geographic information system, the Illinois Resource Information System (IRIS). This document summarizes the findings and recommendations of that study. The full report and a catalog of geographically referenced data have been published separately.

The study was supervised by a Policy Advisory Committee representing the Illinois Institute for Environmental Quality, the Office of Planning and Analysis, and the Bureau of the Budget.

The study examined the availability of geographically referenced data, the uses of such data in Illinois, and how State agencies produce and exchange such information. The state of the art in geographic information systems and the experiences of other states with such systems were also investigated.

In the course of the study, staff members of the Center for Advanced Computation conducted extensive library research and interviewed public officials in almost every department of State government and in several federal and local agencies. A detailed analysis was made of nine broadly representative agencies approved by the Policy Advisory Committee. The nine selected were:

The Department of Business and Economic Development
The Department of Mental Health
The Department of Public Aid
The Department of Public Health
The Illinois Environmental Protection Agency
The Office of Planning and Analysis
The Northeast Illinois Natural Resource Service Center
The Northeastern Illinois Planning Commission
The Southwestern Illinois Metropolitan Area Planning Commission

During the feasibility study, three basic problems with the present system of geographic data collection, processing, and use were examined. First, Illinois suffers from a shortage of important geographic data -- data like current land uses and other fundamental data that are needed to make better decisions and plans. Second, there are no adequate procedures for communicating between agencies what data is needed and what data is available. Finally, the State needs more powerful and flexible tools to analyze the available geographic data.

The Center for Advanced Computation recommends that a computer based geographic information system, IRIS, be developed for Illinois. IRIS, the Illinois Resource Information System, will provide a common library of geographic data and capabilities for analyzing that data. It is also recommended that procedures be established for communicating data needs and data availability among State agencies.

What is a Geographic Information System?

The simplest form of geographic information system is a map. This displays factual data about what exists in space. It may be a road map, a topographic map, or any one of literally thousands of other kinds of maps commonly used to display information about places. Another form of geographic information system is simply a listing, like population by

county. This is the kind of data that can readily be transferred into map form. Again, it provides basic data on "where" something is.

The map, like all geographic information systems, is designed to answer two sorts of questions. We answer the question "what is at location X" by looking directly at the map. We answer the question "where is Y" by looking for Y in the map index and then using the coordinates to point to the map.

A map can display only a few types of information before it becomes too complicated to read. Often, the answers to geographic questions can be found only by laboriously comparing information on a number of maps. For instance, there are many maps which indicate the geological structure and soil types in an area. There are also maps showing the agricultural income in various parts of a region. But a person with a problem requiring a map showing both the soil types and agricultural income of an area would have to draw his own.

The problem is that most of our techniques for handling geographic information are manual techniques. They haven't changed much since the first cartographer drew his first map. The techniques are slow and are limited in analytical capabilities.

A computer based geographic information system can store many maps. When requested, the computer system can combine information selected from any of them and print a single map or table to answer a particular question. For example, suppose an official were using a geographic information system to help determine locations for new parks or recreation areas. Sitting at a typewriter-like terminal in his office, he could rapidly search and display thousands of items of data in the course of an hour or two. He could have the system print a list of all counties in the State with less than 100 acres of park land, or a table showing the park acreage per capita in each county. He could examine natural resource data to determine potential park sites in each county,

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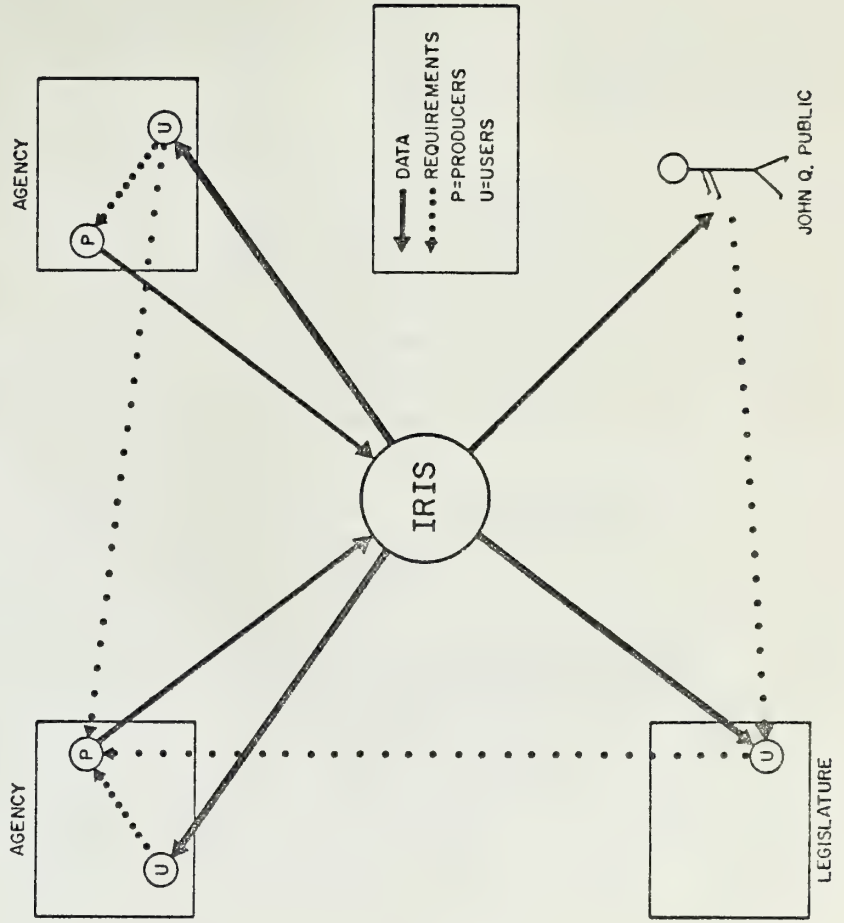
need for Illinois to overcome its information flow problems by developing a geographic information system.

What organizational procedures will help solve the information problem?

The present situation of data duplication, anonymity, and ad-hocracy can be remedied only by opening new channels of communication between agencies. The best way to open and maintain such channels is to establish an information community consisting of those agencies in State government whose missions include the collection, processing, and dissemination of planning and policy data. In addition, the community should be composed of registered and non-registered information users. Information should be produced, not just to the standard of the agency in which it originates, but to a more general standard capable of meeting the needs of most or all registered users. A non-registered user is one whose information requirements are completely met by available data, or one who has no need for active participation in the setting of information standards or requirements.

The information community should maintain channels by which information flows from producer to user, and channels by which user requirements for information flow to the information producers. In order to facilitate the inter-agency transmission of relatively raw geographically referenced information, the assistance of a computer will be necessary. A computer system would make it possible to provide and maintain a common data base and to provide the capabilities for processing this information to meet the needs of many different agencies.

Figure 1 illustrates data flow in an information community. Some data and information requests will still remain entirely within each of the agencies, but the majority of data will flow through the common geographic information system even when the data is being used in the agency in which it originated. The Legislature should be a



THE INFORMATION COMMUNITY
FIGURE 1

registered user of geographic information, both to meet its own needs and to serve as a registered representative of the public. The citizen is included in the network either as a private individual or as a businessman. He can make his special needs for geographic information known through his legislator.

How is geographic information now handled in Illinois?

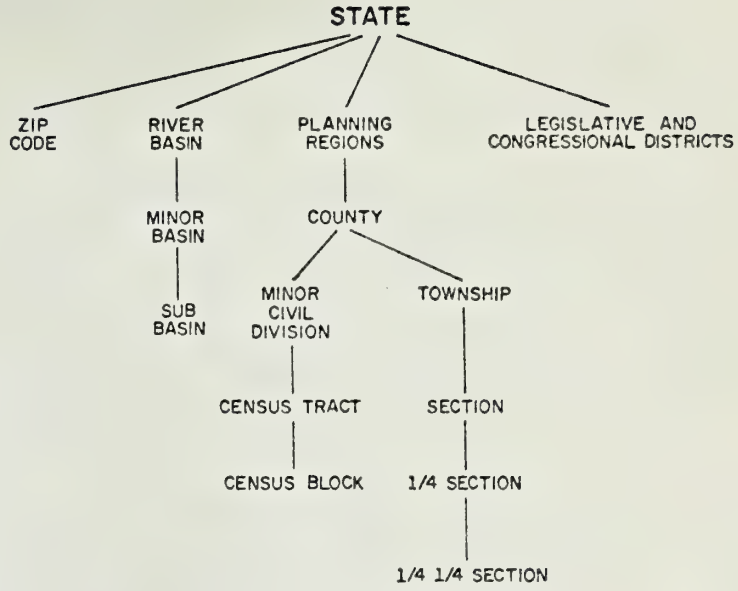
During the feasibility study, we interviewed people in many agencies at both administrative and staff levels. There was an overwhelming interest in developing techniques to better handle geographic information.

Geographic information is used at many levels in Illinois. Figure 1 shows the most popular levels of resolution and shows how these levels are combined into others.

Some socio-economic data is available at all resolutions. However, most of it is collected at relatively fine geographic resolutions. It is published as small tables or maps at the coarse resolution of the county and minor civil division. The socio-economic data base is too large for manual analysis. Most of it is already computerized in a form amenable to statistical analysis.

Most natural resource data in Illinois is collected, published, and used at fine resolutions based upon the legal land survey (sections, ¼ sections, and ¼ ¼ sections in figure 2). Little of this data is computerized. Most is available only as maps which must be manipulated manually.

Geographically referenced data are collected and published at many resolutions, in map, table and computer file form. It resides at literally dozens of different agencies. Even if a user has the funds



LEVELS OF GEOGRAPHIC RESOLUTION

FIGURE 2

and staff to computerize or map all of the data at a consistent resolution, he is faced with the enormous task of interfacing to dozens of agencies to get his data.

The development of the NIPC open space plan is a good example of the barriers now faced by users of geographic data. NIPC used a weighting function analysis of natural resource and socio-economic data to develop their open space plan. NIPC divided its six county region into approximately 16,000 quarter sections (each 160 acre quarter section is ½ mile square). Then about 50 different data variables were collected for each quarter. Each piece of data was given a weight according to its suitability for open space. For example, if the land use data indicated the quarter was already open space, the quarter would be more suitable (high positive weight) than if the land use data indicated it were heavily industrialized (negative weight).

95% of the needed data had already been collected but was available only at the collecting agencies. A two man-year effort was required to go to each of the agencies and get the already existing data. Then a one man-year effort was required to put the data into a consistent quarter section resolution data base. Another two man-year effort was required to put weights on all the data and score each quarter for suitability for open space.

If IRIS had been in existence, the data would have already been available in the required form. The scores for each quarter section could have been computed in minutes, for less than $100. It would have been economically feasible to score the data several times using a variety of interpretations. It would have allowed the presentation of many more alternatives and provided immediate input from and feedback to the policy makers who must eventually make decisions based on geographic data.

Is there any system now operating which Illinois could adopt?

During the feasibility study, we investigated over 30 geographic information systems and potential components of a geographic information system. There is no existing system suitable for Illinois.

Each system studied addresses a different kind of geographic data -- point, network, or area data. No system has the capability to manipulate all three kinds of geographic data. Illinois needs that capability. For example, federal guidelines require that non-point emission sources be considered when developing a river basin water quality plan. Most of the water quality data and models are stream network oriented. However the calculation of non-point emissions sources requires access to land use data (an area type of data) and the ability to overlay this onto the stream network.

Other states have already built partially successful systems to solve some very specific problems. None has a general purpose geographic information system. Illinois is fortunate in that it already has certain basic elements of a comprehensive system. The Department of Transportation and the Chicago Area Transportation Study already use sophisticated transportation models to predict traffic flow using population, employment, land use and other geographic data. The State Water Survey has sophisticated hydrological models. The State Geological Survey has developed the ILLIMAP system which can accurately map geographic data relating to the legal land survey and can be used to convert any geographic point coordinates into the legal system. The Ford Foundation is funding a pilot project called NARIS (Natural Resource Information System) which will provide valuable fine resolution data for northeast Illinois. NARIS is an advanced computer system for handling area geographic data.

Some states have attempted to use general purpose management information systems to attack geographic problems. Unfortunately, the

large data base sizes and unique data access and data output techniques required for a large scale geographic information system are beyond the design constraints of management informations systems. Geographic information systems differ from conventional management information systems in being able to organize and retrieve large quantities of diverse data by both content and location, and in being able to draw maps of raw and analyzed data.

Most of the systems investigated failed to become commonly used decision making tools. There were three common reasons for failure.

1. They were too small in terms of power, flexibility, and data base to be generally useful for other than a small problem area.

2 The system designers had inadequate computer experience or low ability to innovate. As a result, the systems lacked flexibility and economic viability.

3. They were not completely integrated with government, the eventual user, from design through implementation.

These computer systems are expensive to build. A moderate system costs $100,000 to $300,000 to develop, exclusive of data costs. Some have cost over $3 million. Furthermore, most have required new data collection efforts ten times more expensive that the computer system. A well designed computer system, while more expensive, can use existing data and more than recover additional computer system costs by drastically cutting data collection costs. A comprehensive State system capable of manipulating existing point, network, and area data will cost over $4 million. It is important that it be powerful and flexible enough to attack many problem areas, that a sound initial data base be supplied, that competent computer scientists design the system, and that

the design requirements be produced and system development monitored by State government.

What is IRIS?

No existing or planned geographic information system can adequately solve all of the data retrieval and analysis problems described above. The Illinois Resource Information System (IRIS) is the system we recommend to handle point, network, and area data in Illinois. It is designed specifically to solve the day-to-day problems faced by Illinois state personnel -- a powerful, comprehensive geographic information system designed by computer scientists to meet the specifications and needs of its users. IRIS will incorporate and significantly augment the best features of Illimap, NARIS, and other geographic information systems investigated. Although IRIS will be more comprehensive and powerful than any existing geographic information system, it will appear relatively simple to its users. IRIS will be designed for use at an office terminal, without the assistance of a computer programmer, through the use of a variety of conversational terminal commands.

IRIS will be capable of storing, transmitting, and analyzing a large amount of diverse geographically referenced data. It will be able to generate tables of items which occur in a specified region of Illinois or to search throughout Illinois for those areas which have specified properties. IRIS will also be able to produce shaded and labeled maps of Illinois and its subregions, e. g. those townships whose population increased more than ten percent during the last decade and calculate statistical relations among data items retrieved from the system.

IRIS will be able to store and analyze information associated with points, networks, and areas. It will be capable of storing and

retrieving data by means of a variety of commonly used geographic referencing schemes. Users will be able to locate points by latitude and longitude, by state plane coordinates, or by other conventions. IRIS users accustomed to analyzing information about counties would continue to ask IRIS for county information. Users interested in data networks such as highways, streams, or railroads could use IPIS to answer such questions as, "Which segments of roadway had the greatest number of fatal accidents during such-and-such a six-month period?"

IRIS will also be able to compare detailed roadway network information with other detailed files that store information about areas or points. For instance, it will be possible to examine soil and geologic information along highway right-of-ways to determine the ease of roadway improvements. Such detailed cross-referencing is not currently practical.

IRIS will help fill the gap between highly detailed, confidential computer files and very general, low utility summary documents, by allowing access to summary data at a finer resolution than is now available. For instance, it is possible to have an IPIS file with detailed personal income data at the township level without sacrificing the confidential nature of such information at the individual level.

IRIS will provide specialized geographic data service to all of its users, while maintaining the power to retrieve and analyze a variety of large data bases on request. An imaginative user should find many new uses for the system, uses arising from practical experience.

Who would use IPIS?

IRIS is designed primarily for Illinois State agencies. However, IRIS will be of use to all the citizens of Illinois, to regional planning agencies, and to local governments. It is also a tool that can grow over time as more data is put into the system and as usage increases. It is a system that will allow agencies and individuals to share the data that they put into the system and thus eliminate the need for each person collecting his own data. The system will be of use to agency personnel who handle data on a day-to-day basis, and to planners and policy makers who are now making decisions based on inadequate information.

The real benefits of a system like IPIS are better policy making by State and local agencies and greater access to information by citizens and public interest groups.

What will IRIS cost?

It will cost $4 million to develop the IPIS computer system and $1.5 million to provide the initial data base. The system can be made available for a few initial users as early as 18 months after the program starts. However, the total computer system and data base will take three years to complete. The national interest in this subject and the potential value to all 50 states is clear. It is likely that most of the computer system development costs could be borne by one or more federal agencies. Once developed, the operation of a dedicated facility for the State of Illinois will cost $1.5 million per year. In the event of overwhelming demand for these services, IPIS would be capable of expanding to a $3 million per year system to support the maximum conceivable load.

How will the system be developed and managed?

This, of course, is up to the State. It is recommended that the developmental work be done by the University of Illinois under the supervision of the State. At the end of the three year development phase, the system should be implemented as an operating feature of State government in an environment such as its Office of Planning and Analysis or its Management Information Division.

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